CLAIMS

WHAT IS CLAIMED IS:

1. A method of computing FIR filter coefficients, comprising the steps of:

inputting a filter order of a universal maximally flat FIR filter, a number of zeros at $z=-1$, and a parameter for a group delay at $z=1$, the filter order being a positive integer, the number of zeros being an integer equal to or more than zero, the parameter being a rational number;

executing a first operation by a first recurrence formula which includes parameters for the filter order, the number of zeros, and the group delay, and provides coefficients in Bernstein form representation of a transfer function of the universal maximally flat FIR filter;

executing a second operation by a second recurrence formula composed of additions, subtractions, and divisions by 2, by using a resultant of the first operation as an initial value; and

extracting impulse response coefficients of the universal maximally flat FIR filter from a resultant of the second operation.

2. The method according to claim 1, wherein:

the first recurrence formula is expressed as

$b_j' = (-1)\{(2d)\, b_{j-1}' + (j - 1)\, b_{j-2}'\} / (N - j + 1)$ where $1 \leqq j \leqq N$ with $b_0' = 1$ and $b_{-1}' = 0$,

wherein the filter order is N, the parameter for the group delay is d, coefficients in Bernstein form representation of a transfer function of the universal maximally flat FIR filter are b_j';

the resultant of the first operation is expressed as $B'=\{1, b_1', \ldots, b_{N-K}', 0, \ldots, 0\}$, wherein the number of zeros is K;

the second recurrence formula is expressed as

$h_i^{(p)} = (1 + E)\, h_i^{(p-1)} / 2 + (1 - E)\, h_{i-1}^{(p-1)} / 2$ where $1 \leqq p \leqq N$, $0 \leqq i \leqq p$ with $h_0^{(0)} = B'$ and $h_{-1}^{(p)} = \{0, \ldots, 0\}$,

wherein a sequence for computing impulse response coefficients of the universal

maximally flat FIR filter is expressed as $h_i^{(p)}=(h_{i,j}^{(p)})=(h_{i,0}^{(p)},h_{i,1}^{(p)},\ldots)$, and an arbitrary sequence A_i is expressed as $E^j = E\ (E^{j-1}A_i\ )$, $E^1A_i = EA_i = A_{i+1}$, $E^0A_i = A_i$ in which a forward shift operator satisfying the expression is E; and

the impulse response coefficients extracted from the resultant of the second operation are expressed as $h_i = h_{i,0}^{(N)}$ where $0 \leqq i \leqq N$

3. A program for computing FIR filter coefficients, the program causing a computer to execute the steps of:

determining every element of a single-dimension array B' using a filter order N being a positive integer of a universal maximally flat FIR filter, a number of zeros K at z=-1, K being an integer equal to or more than zero, and a parameter d for a group delay at z=1, d being a rational number, all of which are provided by inputs, by changing in sequence an index j from 1 to N-K in a recurrence formula B'[j] = (-1) × {(2d)B'[j-1] + (j-1)B'[j-2]} / (N – j + 1), the single-dimension array having N+1 elements B'[j] where $0 \leqq j \leqq N$, in which an element B'[0] thereof is initialized to 1 and all the elements thereof except the element B'[0] are initialized to zero;

determining every element of a three-dimension array r by sequentially changing, in the order of indexes j, i, p, an index j from 0 to N-p, and an index i from 0 to p, an index p from 1 to N in a recurrence formula r[p,i,j] = (r[p-1,i-1,j] - r[p-1,i-1,j+1]) / 2 + (r[p-1,i,j] + r[p-1,i,j+1]) / 2, the three-dimension array r having N^3 elements r[p,i,j] where $0 \leqq p \leqq N$, $0 \leqq i \leqq N$, $0 \leqq j \leqq N$, in which elements r[0,0,j] thereof where $0 \leqq j \leqq N\text{-}K$ are initialized to elements of the single-dimension array B'[j] where $0 \leqq j \leqq N\text{-}K$, and all the elements thereof except the elements r[0,0,j] are initialized to zero; and

extracting elements r[N,i,0] of the three-dimension array r where $0 \leqq i \leqq N$ as the impulse response coefficients of the universal maximally flat FIR filter.